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ABUNDANCES OF MICROMETAZOANS IN THREE SANDY BEACHES IN THE ISLAND AREA OF WESTERN LAKE ERIE[1]

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ABSTRACT. During August 1978 the interstitial micrometazoa of 3 beaches on Kelley's, Pelee and South Bass Islands in the western basin of Lake Erie were sampled. Representatives of the following taxa were found: Acarina, Cladocera, Copepoda, Ostracoda, Gastrotricha, Oligochaeta, Rotifera, Tardigrada and Turbellaria. The South Bass Island beach had the greatest mean density of micrometazoans (46.5/cm^3), followed by the Pelee Island (14.2/cm^3) and Kelley's Island (5.2/cm^3) beaches. The South Bass community was numerically dominated by turbellarians, the Pelee community by rotifers and the Kelley's community by rotifers and gastrotrichs. The mean density of total fauna decreased with depth in the sand (70% in the top 1 cm) except at subsites in the wave-influenced zone at the water's edge where 60% of the fauna were found in the 2–3 cm depth fraction. The densities of most taxa were significantly affected by an interaction between position on the beach and depth in the sand. Densities of the 4 most abundant rotifer genera (*Trichocerca, Lecane, Wierzjskiella* and *Cephalodella*) varied among beaches and as a function of position and depth. The gastrotrich genera *Chaetonotus, Ichthydium* and *Lepidodermella* exhibited strong differences in their distributional patterns, with only one genus abundant at any beach, position or depth. The tardigrades *Hypsibius augusti* and *Hypsibius saltursus* were found in low densities (combined mean of 0.5/cm^3) below the waterline only on Pelee Island.

OHIO J. SCI. 82(5): 246, 1982

INTRODUCTION

Pennak (1940) described a diverse community of micrometazoans living among the sand grains of several Wisconsin beaches. A typical 10 cm^3 of surface sand taken 150 cm shoreward from the water's edge on those beaches contained 10,000 protozoans, 400 rotifers, 40 copepods, 20 tardigrades and lesser numbers of other micrometazoans such as gastrotrichs, oligochaetes and turbellarians. Although

[1]Manuscript received 20 January 1981 and in revised form 28 July 1981 (#81—3).

similar communities in marine habitats have received considerable attention since Pennak's study (Svedmark 1964, Fenchel 1978), the micrometazoa of sandy freshwater habitats have been largely ignored in North America, and no published accounts are available for Lake Erie. A lack of suitable keys, scattered literature, and various sampling and extraction difficulties may account for this lack of information. The objectives of this study were to identify the taxa of micrometazoa present in selected Lake Erie beaches and to estimate their relative abundances with respect to depth in the sand and position on the beach.

METHODS AND MATERIALS

The 3 study sites were located on beaches on Kelley's Island, Pelee Island and South Bass Island in the western basin of Lake Erie. The small beach on S. Bass Island faces northeast and lies in a protected cove near the town of Put-in-Bay, Ohio. The beach on Kelley's Island is large (200 m long) and open to the north; the study site was located at the far eastern end of the beach in order to avoid areas used extensively for recreation. The Pelee Island beach is on the eastern side of the island, well exposed to wave action. This beach had the steepest grade of the three. All beaches were sampled within a 3-wk period in August 1978.

Each beach site was divided into 3 subsites based on distance from the water's edge. One subsite was located at the water's edge (0 m position), a second subsite was located 1 m shoreward (+1 m position), and a third subsite was located 1 m lakeward (−1 m position) (fig. 1). At each position 3 cores were obtained for faunistic analysis by inserting a 20-cm^3 plastic syringe with the tip cut off into the sand to a depth of 3 cm. Upon removal, the cores were extruded by pressing on the plunger, and sliced off at 1 cm intervals. Each depth fraction (0–1, 1–2 and 2–3 cm) was then placed into a numbered 75-ml glass jar. The fauna were extracted from each depth fraction by serial decantation with 1% $MgCl_2$ and preserved by adding sufficient 100% formalin with rose bengal to bring the concentration of formalin in the supernatant to 10%. (Rose bengal stains the fauna bright red for ease of recognition.) Multiple, whole Sedgwick-Rafter cell counts conducted under a stereomicroscope at 50× were used to enumerate the fauna. Cells were filled by decanting the excess fluid from each jar, swirling the remaining contents, and transferring 1-ml aliquots to the cells via a large bore pipette. Six aliquots per jar were counted. This procedure avoids sieving losses and approaches 100% efficiency in sands with little organic matter. The density of each taxon was calculated as follows:

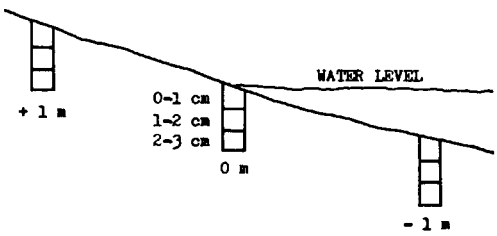

FIGURE 1. Diagrammatic model of the sampling design at each beach site. Three subsamples were taken at each position on the beach (1 m shoreward, water's edge, and 1 m lakeward); 3 depths (0–1, 1–2, and 2–3 cm) were included in each subsample.

$$\text{Number/cm}^3 = (N/S)(Df/Cf)$$

where N = sum of individuals from cell counts S = cm^3 of sand from which the fauna were extracted (1.9) Df = ml fluid remaining in jar after decantation Cf = ml fluid used in cell counts (6).

Due to the preliminary nature of the study, no water or granulometric analyses were undertaken.

RESULTS

Representatives of the following taxa were encountered during the study: Acarina, Cladocera, Copepoda, Ostracoda, Gastrotricha, Nematoda, Oligochaeta, Rotifera, Tardigrada and Turbellaria. The rotifers, nematodes and turbellaria were the most abundant taxa with the gastrotrichs and oligochaetes consistently present. The remaining taxa were present sporadically and usually represented by only a few individuals. Nineteen species of rotifers in 8 genera (*Cephalodella, Colurella, Dicranophorus, Euchlanis, Lecane, Lepadella, Trichocerca* and *Wierzjskiella*) were recognized. Many of these species were undescribed. Those rotifers identified to species were *Colurella dicentra, C. obtusa, C. sinistra, Dicranophorus hercules, Lecane closterocerca, L. cornuta, L. hamata, L. lunaris, L. psammophila, L. pyriformis, L. scutata, L. tethis,* and *Wierzjskiella velox*. Four genera of gastrotrichs (*Chaetonotus, Ichthydium, Lepidodermella* and *Polymererus*) were present; none were identified to species.

All tardigrades found during the study were either *Hypsibius augusti* or *H. saltursus*. All annelids belonged to the family Naididae and the remaining taxa were not identified further.

The density of micrometazoa ranged from 175/cm^3 in the top 1 cm of sand at the +1 m position on S. Bass Island to 1.1/cm^3 in the top 1 cm of sand at the 0 m position on Kelley's Island (table 1). The S. Bass Island site also had the greatest overall mean density of micrometazoans (46.5/cm^3), followed by the Pelee Island site (14.2/cm^3) and the Kelley's Island site (5.2/cm^3). Depthwise decreases in the density of micrometazoans were observed at the +1 m and −1 m positions at the S. Bass and Kelley's Island sites. The reverse trend was exhibited at the 0 m position at all sites. Combining the +1 m and −1 m positions from all sites showed that 70% of the fauna were found in the top 1 cm of sand, 20% in the 1–2 cm depth fraction and 10% in the 2–3 cm depth fraction. At the 0 m positions only 10% of the fauna were found in the top 1 cm of sand, while 30% were found at 1–2 cm and 60% at 2–3 cm. The +1 m position at the Kelley's Island site was anomalous in that it exhibited a density trend similar to the 0 m positions. Individual taxa listed in table 1 sometimes demonstrated unique

TABLE 1

Mean number of micrometazoans/cm^3 from 3 Lake Erie beaches, August 1978.

Island	Subsite	Taxon					
		Total*	Rotifera	Nematoda	Turb.	Gast.	Olig.
South Bass	+1m 0–1cm	175.4	7.2	14.4	151.4	2.4	0.0
	1–2cm	6.4	3.5	0.9	1.7	0.3	0.0
	2–3cm	6.2	4.1	2.1	0.0	0.0	0.0
	0m 0–1cm	19.8	10.0	1.2	6.6	0.3	0.3
	1–2cm	59.8	7.0	1.2	49.5	0.9	1.2
	2–3cm	87.6	4.8	1.3	78.2	3.0	0.3
	−1m 0–1cm	33.2	10.1	14.1	6.5	1.8	0.0
	1–2cm	18.0	7.3	9.0	1.4	0.3	0.0
	2–3cm	9.9	2.9	5.7	0.8	0.0	0.0
Pelee	+1m 0–1cm	1.6	0.0	0.0	0.0	1.6	0.0
	1–2cm	13.1	9.8	0.4	1.3	2.9	0.0
	2–3cm	16.8	11.2	2.1	0.0	3.3	0.2
	0m 0–1cm	1.8	0.2	0.0	0.0	1.1	0.0
	1–2cm	10.7	2.2	0.3	1.3	1.0	0.6
	2–3cm	48.9	23.1	0.4	0.0	8.0	5.7
	−1m 0–1cm	8.1	4.1	1.2	0.0	2.4	0.4
	1–2cm	3.3	1.4	0.3	0.0	0.9	0.4
	2–3cm	8.1	2.1	0.7	0.0	1.4	2.2
Kelley's	+1m 0–1cm	8.2	5.3	0.0	0.0	2.9	0.0
	1–2cm	4.5	2.5	0.7	0.0	1.3	0.0
	2–3cm	4.4	2.3	0.2	0.6	1.3	0.0
	0m 0–1cm	1.1	0.8	0.0	0.3	0.0	0.0
	1–2cm	3.7	0.5	0.3	2.0	0.9	0.0
	2–3cm	2.6	0.4	1.3	0.3	0.6	0.0
	−1m 0–1cm	11.6	3.2	4.7	0.0	2.6	1.1
	1–2cm	9.8	0.2	2.9	3.6	3.1	0.0
	2–3cm	1.5	0.0	0.5	0.5	0.5	0.0

*Includes all taxa encountered during the study.

density trends different from those shown by total fauna.

In addition to differences in overall mean density of micrometazoa, the 3 sites also differed in the relative abundances of shared taxa, and genera and species within certain taxa. The S. Bass Island community was numerically dominated by the turbellaria, followed by the rotifers and nematodes. The Pelee Island community was comprised predominately of rotifers. Rotifers and gastrotrichs dominated the Kelley's Island community, with the nematodes and turbellaria equally abundant, but fewer in number. Oligochaetes never reached high densities. The dominant taxon also differed within sites as a function of position and depth. For example, at the S. Bass Island site, turbellaria were the most abundant organisms at +1 m/0–1 cm, rotifers dominated at 0 m/0–1 cm, and nematodes were most numerous at −1 m/2–3 cm. Vertical changes in the relative abundances of taxa were evident at all sites and positions (table 1).

Results of analysis of variance tests showed significant ($P<.05$) differences in density among sites for total micrometazoa and for all taxa except gastrotrichs. Nematode, turbellaria and oligochaete densities varied significantly by position on the beach, and turbellaria and oligochaete densities changed significantly with depth in the sand. Second order interactions between site, position and depth were significant for nearly all taxa.

Cephalodella, Lecane, Lepadella, Trichocerca and *Wierzjskiella* accounted for nearly 85% of the rotifer fauna at the study sites. The mean density for each of these genera is given by site, position and depth in table 2. The beach site on S. Bass Island was comprised largely of individuals of *Lecane,* which dominated numerically at all positions and depths. At the Pelee Island site, *Lepadella* made up 61% of the rotifer fauna; however, at the −1 m position *Trichocerca* (28%) and *Lecane* (27%) were more abundant than *Lepadella* (21%). Individual rotifers were much more evenly distributed among genera at the Kelley's Island site where *Trichocerca, Lecane, Wierzjskiella* and *Cephalodella* abundances varied as a function of position and depth. The +1 m position was dominated by *Wierzjskiella* (28%), the 0 m position by *Lecane* (43%) and the −1 m position by *Trichocerca* (45%). *Trichocerca* and *Lecane* (41% each) were most abundant in the top 1 cm of sand, *Wierzjskiella* (46%) and *Cephalodella* (26%) at 1–2 cm and *Trichocerca* (41%) at 2–3 cm.

Only individuals of the genus *Lecane* were consistently identifiable to species. The taxonomy of this genus is based primarily upon lorica morphology, which is more readily visible after the contraction of soft body parts caused by the extracting and preservation techniques described above. Members of this genus are small (usually less than 150 μm long), dorsoventrally flattened rotifers common to littoral vegetation and to psammic habitats. Most species were widely distributed among beaches with only *L. closterocerca* and *L. scutata* (S. Bass Island) and *L. psammophila* (Pelee Island) restricted to one site. Further sampling would probably show these 3 species to be common to more than one beach. *L. pyriformis* (43%) and *L. closterocerca* (28%) were the most abundant of the 7 species present in the S. Bass community. *L. tethis* (28%), *L. lunaris* (19%) and *L. hamata* (18%) comprised the majority of the *Lecane* fauna at the Pelee Island site, with 3 other species present in smaller numbers. *L. tethis* (75%) dominated at the Kelley's site with most individuals living in the top 1 cm of sand: *L. pyriformis* comprised 20% and *L.* sp. A the remainder.

Gastrotrich genera exhibited strong differences in their distributional patterns (table 2). *Ichthydium* was the most abundant genus at the Pelee Island site comprising 69% of the gastrotrich fauna overall and 97% at the 0 m position. *Chaetonotus,* the other genus present, was more abundant at the −1 m position (99%) and in the top 1 cm of sand (82%). *Chaetonotus* com-

TABLE 2

Mean number of rotifers and gastrotrichs/cm³ by genera from 3 Lake Erie beaches, August 1978.

Island	Subsite	Rotifers*					Gastrotrichs**		
		Ceph	Lecane	Lepad	Trich	Wierz	Chaet	Ichth	Lepid
South Bass	+1m 0–1cm	2.5	3.6	0.0	0.7	0.0	2.4	0.0	0.0
	1–2cm	0.0	3.5	0.0	0.0	0.0	0.0	0.3	0.0
	2–3cm	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
	0m 0–1cm	0.0	8.9	0.3	0.0	0.0	0.3	0.0	0.0
	1–2cm	0.0	6.6	0.0	0.0	0.0	0.9	0.0	0.0
	2–3cm	0.0	2.6	0.3	0.3	0.0	3.0	0.0	0.0
	−1m 0–1cm	1.6	7.3	0.0	0.0	0.0	1.4	0.4	0.0
	1–2cm	0.5	4.8	0.0	0.0	0.0	0.3	0.0	0.0
	2–3cm	0.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Pelee	+1m 0–1cm	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
	1–2cm	0.0	1.0	8.8	0.0	0.0	0.0	2.9	0.0
	2–3cm	0.0	0.3	8.4	0.0	0.0	0.0	3.3	0.0
	0m 0–1cm	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.0
	1–2cm	0.0	0.0	0.5	0.0	0.0	0.0	1.0	0.0
	2–3cm	0.6	0.7	13.8	0.0	0.0	0.0	8.0	0.0
	−1m 0–1cm	0.0	0.9	1.6	1.1	0.3	2.4	0.0	0.0
	1–2cm	0.0	0.0	0.0	1.0	0.0	0.9	0.0	0.0
	2–3cm	0.0	0.7	0.0	0.0	0.0	2.1	0.0	0.0
Kelley's	+1m 0–1cm	0.8	1.4	0.0	0.4	1.1	0.4	0.0	2.6
	1–2cm	0.7	0.2	0.0	0.0	1.5	0.9	0.0	0.4
	2–3cm	0.6	0.2	0.0	1.1	0.3	0.8	0.0	0.6
	0m 0–1cm	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0
	1–2cm	0.2	0.0	0.0	0.4	0.0	0.9	0.0	0.0
	2–3cm	0.0	0.4	0.0	0.0	0.0	0.6	0.0	0.0
	−1m 0–1cm	0.2	0.5	0.0	1.5	0.2	1.2	0.0	1.4
	1–2cm	0.0	0.2	0.0	0.0	0.0	2.9	0.0	0.2
	2–3cm	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0

*Ceph = *Cephalodella*, Lepad = *Lepadella*, Trich = *Trichocerca*, Wierz = *Wierzjskiella*
**Chaet = *Chaetonotus*, Ichth = *Ichthydium*, Lepid = *Lepidodermella*

prised 90% of the gastrotrich fauna at the S. Bass Island site, dominating at all positions and depths. *Polymererus* was rare.

H. augusti and *H. saltursus* were found only at the −1 m position at the Pelee Island site. Their combined density at this position was 0.5/cm³. Tardigrades commonly reach densities of 100/cm³ in sublittoral sandy areas of western Lake Erie not considered in this paper.

DISCUSSION

The community of interstitial micrometazoans described in this study was diverse with potentially complex interactions with each other and with their physical and chemical environment. The results of analysis of variance tests support the observed density trends and suggest synergistic effects on the fauna by the changes in physical and chemical factors associated with changes in site, position and depth. These factors include exposure to wave action, quantity of organic matter available as food, sand grain morphometry, amount of water in the interstitial spaces, oxygen concentration, pH, temperature and others.

An interesting and consistent trend for total micrometazoa and for most taxa was

the reversal of the usual depthwise decreases in density at the 0 m position on the beaches. I suggest the controlling factor is the stress imposed on the fauna by sand grain movement in response to the impact of wavelets upon this area of the beach. The interstitial animals can avoid this stress by moving deeper into the sand. Pennak (1940) noted lowered densities of micrometazoa in the top 1 cm of sand at similar positions on Wisconsin beaches. Depth-related changes in abundance were more pronounced for larger fauna such as oligochaetes and turbellaria. Possibly they are more susceptible to injury from sand grain movement than are the smaller organisms, which can remain in the interstitial spaces. Alternately, the wave-impacted zone may have less detrital food material than areas above and below the waterline, and thus support diminished populations. An increase in faunal density with depth was also observed at the +1 m position at the Pelee Island site. This beach was the steepest of the 3 and appeared to have the coarsest sand. These conditions may lead to rapid drainage and evaporation of the interstitial water at this position, resulting in increased stresses due to desiccation. Either migration of the fauna to deeper sediments or differential mortality rates could explain the depthwise increase in density at this site and position.

Changes in dominant taxa by site, position and depth suggest each taxon is affected differently by the beach habitat factors discussed above. Trends exhibited by individual taxa are composites and can differ from trends at lower taxonomic levels (Evans 1980). For example, total rotifer density did not differ significantly with depth in the sand, but *Lecane* densities did ($P<.05$). Also, total gastrotrich density did not differ significantly among sites due to the effect of the most abundant genus, *Chaetonotus;* but *Ichthydium* and *Lepidodermella* densities did differ significantly ($P<.05$) among sites.

The distributional patterns of the rotifer and gastrotrich genera and *Lecane* species revealed displacements of population centers by site, position and depth. Such displacements could result from competitive interactions, preferences for a particular physical-chemical milieu, the availability of certain food resources, or combinations of these factors.

Because this study was restricted to a short time period, the degree to which temporal variability and stochastic events affected the observed density trends is not known.

LITERATURE CITED

Evans, W. A. 1980 Seasonal abundances of psammic rotifers along a gradient of acid mine pollution in a southeastern Ohio stream. Unpubl. Ph.D. Thesis, Ohio Univ., Athens, OH.

Fenchel, T. M. 1978 The ecology of micro- and meiobenthos. Ann. Rev. Ecol. Syst. 9: 99–121.

Pennak, R. W. 1940 Ecology of the microscopic Metazoa inhabiting sandy beaches of some Wisconsin lakes. Ecol. Monogr. 10: 537–615.

Svedmark, B. 1964 The interstitial fauna of marine sands. Biol. Rev. 39: 1–42.